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TRAINING GUIDE

AERIAL OBSERVER TRAINING

U. S. Department of Agriculture

FOREST SERVICE

Northern Region

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CONTENTS

	Page
Introduction	1
History of Aerial Fire Control	1
History of the Forest Unit	2
Organization of the Forest Unit	2
Responsibilities of Key Individuals	3
Aerial Observers' Responsibilities	3
Responsibility of Pilots	4
Safety of Aerial Operations	4
Excessive turbulence	4
Local storms	5
Strong winds	5
Reduced visibility	5
Piloting by observers	5
Adherence to mapped patrol routes	6
Qualifications of pilots	6
Signal code cards	6
Use of parachutes	7
Smoking while in flight	7
CAA rules and regulations	7
Detection planning	7
Check List of Air Observer Duties.	7
Pre-flight duties	7
In-flight duties	8
Between-flight duties	9
Aerial Observation Techniques	9
Learning the Country and the Patrol Routes	10
Area of Responsibility	11
Time and Length of Observations	11
Altitude of Flight	12
Angle of Observation	12
Sun Angle	12
Figures 1, 2, 3, and 4	following page 12
Visibility Factors	13
Effects of haze	13
Effect of Background	14
Effects of fuels and moisture	14
Observation Methods	14
Position plane for best observation	16
Choosing Special Patrol Routes	16
Visibility Aids	16
Use of Maps and Photographs	17
Map-Reading Instruction	18
Fire Location	18
Fire Scouting	19
Fire Reporting	20
Aerial Delivery	20

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Introduction

Aerial detection is not new to the thinking of fire planners. It has been tried off and on for many years and more recently has been commonly used, to a considerable extent during critical periods, to supplement ground detectors.

In 1945 the "Continental Area" was established to develop planning methods and test the possibility of combining the two methods of detection --- air and ground. We believed that air detection could be made much more effective if flight routes, time of patrol, and techniques of observation could be carefully arranged.

The combined air-ground detection system, as now used in Region 1 and elsewhere is far from being "foolproof." We recognize that a lot of research, development and planning is needed to reach maximum efficiency. However, it appears to have many advantages, as it is now used, in the light of present-day financing. Region 1 has 12 units now (1954) which combine air and ground detection.

Planning has advanced to a point where it is desirable and necessary to standardize methods[1]/. Systematic and uniform training of aerial observers will do much to improve detection plans and action. The contents of this guide will be of interest to all supervisory personnel responsible for coordinating aerial activities on the forest.

History of Aerial Fire Control

All personnel connected with an air unit should be familiar with the history of aerial developments. A briefed summary is presented for use in training of air observers.

History of aerial fire-control in Region 1 dates from the early summer of 1925. In this year Howard Flint organized the first scheduled air patrol with the operations base at Spokane, Washington. Nick Mamer, a pilot famous in the early history of the airmail, cooperated with Howard Flint and contracted the flying. Planning for this early patrol consisted of a flight map upon which a course was plotted from mountain to mountain and from town to town. The observation strip was 50 miles wide --- 25 miles on each side.

Cargo dropping from airplanes --- first employed on a forest fire in 1930 --- was accepted as practical in 1935. Aerial photography had also expanded to a full-scale operation by 1935. T. B. Pearson originated the idea that smoke-jumping, as it is now called, might have possibilities. Pearson hired a professional jumper, Buddy Bruce, to conduct tests. These consisted of dropping dummies at low elevations in mountainous terrain. A year later (1935) Bruce jumped twice at low elevations, but the project was discontinued due to the risks involved.

1/ Planning, developing and operating a combined air-ground detection system, U. S. Forest Service, Region One.

During the period 1936-1939, aerial delivery of cargo was thoroughly tested and the methods improved. Bombing of fires with water in various kinds of containers and some spray tests were tried in Regions 1 and 6 without much success. It was during a water bombing project near Winthrop, Washington, that the idea of parachuting men to forest fires first received serious consideration. Mr. Dave Godwin of the Washington office reported that the water bombing project did not appear practical, and proposed that the balance of the development funds be used to explore the possibilities of "smokejumping." Approval was given and following approximately 60 experimental jumps in 1939, a conclusion was reached that men could safely land in green timber at ground elevations from 2000 to 6800 feet.

The first practical use of smokejumpers was in 1940. Region 1 had 6 men who jumped throughout the fire season on a few fires. Major Lee, credited with the initial development of the U. S. Army Paratroops, saw the training, equipment and jumping, and later employed Forest Service ideas in organizing the first paratrooper training school at Ft. Benning, Georgia. The smokejumper organization continued to expand and devlop techniques throughout the period 1941 to 1946. Personnel totalled 150 men plus overhead in 1946. During this period several groups of military personnel were given special training in timber jumping.

In 1945 the Continental Area was initiated to devlop planning methods and test the possibilities of aerial detection and aerial smokechasing.

Although equipment development work of necessity progressed "hand-in-hand" with smokejumping and aerial detection, in 1953 Region 1 was designated as the All-Service Aerial Development Center. Aerial development of all-Service and regional nature is now assigned to the center. In 1954 the Missoula Aerial Depot was completed and occupied.

History of the Forest Unit

If the local or forest air-ground detection unit has been in operation, aerial observers should be made acquainted with the developments to date. The following are suggested subjects:

1. When was combined air-ground detection initiated?

2. What are the results to date? What has been gained? Lost? What are the corrective measures planned?

3. What is the status of air-patrol planning?

Organization of the Forest Unit

The forest organization should be developed and the detection, dispatching and suppression phases outlined and explained in detail. Emphasis should be given to the coordination of effort required.

Responsibilities of Key Individuals

In development of the responsibilities of the key individuals particular attention should again be given to the need for coordination of activities. For example, lookout-firemen and air observers are working as a team. Lookout-firemen have been selected to detect fires where a high frequency of observation is required. The aerial observer is used to detect fires where a high percent of visible or seen-area is required but where the frequency of observation may be safely reduced. Approximately 75 percent of the fire occurrence may be expected within the seen area of fixed detectors.

Aerial Observers' Responsibilities

Air observer responsibilities:

1. Learn patrol routes thoroughly so frequent reference to map for orientation is unnecessary.

2. Concentrate on observation of area while in flight. Practice and learn techniques of observation.

3. Check pilot to insure that he flies closely to the planned observation route and at proper elevations unless directed otherwise.

4. Report accurately the location of all fires of unknown or questionable cause.

5. Assist lookout-firemen as necessary in fire location or detection.

6. Scout going fires to report progress or conditions as required.

7. Assist in development of patrol routes, seen-area maps, and techniques of observation.

8. Become familiar with safety requirements, including pilot responsibilities. Follow closely the regulations and policy regarding air safety.

9. Maintain flight records, report forms, statistics, etc., assigned to you, currently and completely.

10. Learn and observe rules for proper use of radio.

11. Cooperate with district dispatchers and others in all aerial activities as directed by your supervisor.

12. Assist in smokechasing whenever possible.

13. Become expert in aerial delivery of cargo and safety of dropping.

14. Check pilot on safety in flight, inspections, fuel reserves, etc., as required. Report dangerous or unsound flying habits.

Responsibility of Pilots

Detection flying is usually done by contract pilots, although in a few cases Forest Service employed pilots and government planes have been used. Contract pilots as a rule are eager to make aerial detection a success. It can usually be arranged for them to attend training sessions for aerial observers and this should be done whenever possible. Not only are pilots responsible for safety of the aircraft and flying, but they should understand the need for close adherence to patrol routes and the methods used in developing them. Pilots have in many cases made first discoveries of smokes and are usually made responsible for detection coverage in a part of the area under observation. Pilots should clearly understand their responsibilities as follows:

1. Safety of airplane, cargo, and passengers during takeoff, landing or in flight.

2. Thorough and experienced preflight inspection and maintenance of aircraft in accordance with approved CAA requirements.

3. Unless directed by the observer to vary the patrol pattern for improved visibility, special coverage requirements, scouting, etc., the pilot is expected to adhere closely to the established patrol routes. Elevation is as important as the flight path.

4. The pilot may be made responsible for coverage of part of the observation area and should be given training in aerial observation.

5. In some units the pilot is responsible for installation and maintenance of special equipment, such as radio, flares, etc.

Safety of Aerial Operations

Safety is the controlling guide in all air operations. The Air Operations Handbook and the Forest Service Safety Code provide a ready reference to information for aerial observers and supervisory personnel which will not be duplicated in this training guide. They should be available for reference at the operations base. Some of the safety factors not specifically covered in the Air Operations Handbook are as follows:

Excessive turbulence. On hot summer days the patrol plane will often encounter turbulent air. This is particularly true on windy days in the rough topography associated with aerial patrol. Normally so-called "rough air" does not require a change in patrol routes since this factor was taken into consideration in the route planning. When excessive turbulence is encountered, the aerial observer may find that an increase in the general patrol elevation will result in smoother flying without reducing cruise speed. On clear days, and when the direction of flight is generally east-to-west or west-to-east, little loss in detection will result from this deviation. The air movement causing the excessive turbulence will also cause "sleepers" to smoke up -- unless the fire happens in a very sheltered location -- and the increase in visibility distance will offset to a considerable extent the increase in distance from the observer to the smoke.

An increase in altitude when the general flight path is north-to-south or south-to-north should be given more consideration. In this direction the detection of shaded smokes in late afternoon is made more difficult when looking towards the sun. It is general practice for experienced observers to move the plane nearer to the shadows under these conditions and as a result an increase in elevation adds still greater distances between the observer and those smokes "down-sun", but still within the area of responsibility. A thorough knowledge of the techniques of aerial observation will enable observers to recognize when elevations may be increased under these conditions.

A general practice, with excessively turbulent air, is to increase altitude on east-to-west or west-to-east runs and request a slower flying speed, but at the planned altitude on the north-to-south and south-to-north runs. It is general practice to slow cruising speeds in extremely rough air -- both for comfort and to ease flight stresses on the airframe.

Local storms may sometimes be encountered on patrols made soon after the lightning occurrence. Usually the presence of heavy rain, which might limit visibility to an extent where flying is unsafe or against CAA regulations, retards possible fires to an extent where immediate detection is not important. Observers may direct the pilot to "skirt" these rain squalls as necessary and confine observation to the dry areas. When general flying conditions are hazardous the pilot may return to the field or elect to land at other fields within or adjacent to the area until conditions improve. A telephone or radio report should be made of any unscheduled landing.

As a general rule the presence of rain in the area is reflected in lowered fire dangers and a reduced need for general or specialized patrols. Intensive patrol under these conditions is rarely necessary.

Strong winds dangerous to takeoff and landing of aircraft should be avoided and patrols delayed when in pilot's judgment these conditions prevail. When already airborne the pilot may elect to delay landing for a few minutes if in his judgment the high wind is of the "squall" type common to the mountains; or he may elect to land at an alternate airport where length or direction of runways are better suited to a safe landing.

Reduced visibility due to smoke, dust, or rain cannot always be avoided. If heavy smoke, caused by forest or other fires, or dust are the cause, patrol may be especially important because of hazardous conditions existing at the time. Patrol flights will be made if conditions permit contact flight as defined in CAA flight rules. Observers should adjust patrol routes as required and in accordance to fire dangers, storm occurrence, and techniques of observation.

Piloting by observers, while on patrol flights, has often been discussed. In general this practice is discouraged for the following reasons:

1. Aerial observers through training, knowledge of patrol-route planning, fire experience, and proven ability are better qualified than pilots in general to discover small fires difficult to see. They should keep eyes and interest on detection rather than flying the plane.

2. Qualified and experienced pilots can usually do a better job of following closely the patrol route.

3. Pilots can safely fly the plane and do some observation or detection looking. This observation cannot be as complete or detailed as that done by the observer.

The reasons advanced for allowing the air observer to occasionally pilot the plane are:

1. On suitable flying days pilot and observer may alternate detection and flight responsibilities providing some measure of rest for both.

2. Some knowledge and piloting experience makes the observer feel more at ease in rough air and when steep banks or other maneuvers are necessary in fire scouting.

3. The observer could, if necessary, make an emergency landing.

Circumstances and experience should dictate. We have several observers who are qualified pilots and some pilots are by experience qualified observers -- usually from the standpoint of fire discovery methods only. In any case, Forest Service observers should not make landings or takeoffs, except in emergencies, or fly at any time except under the best of flight conditions. Under no condition does the observer assume the responsibilities of the pilot.

Adherence to mapped patrol routes is an important safety requirement in mountain flying. Although deviations are made for detection purposes such deviations are minor and would have little bearing upon finding the plane in the event of a crash landing.

Observers should make sure that central dispatchers know the general patrol route and direction and approximate duration of flight. This may be done by radio if major deviations are required after starting the patrol. Minor changes in the flight path such as special strike area coverage are known by the lookout firemen since the need for these local deviations is determined through radio communication with them.

If radio contacts with the lookouts are not required, as might be the case on a general security check with no lightning for several days, the observer should notify the nearest lookout of the plane location approximately each quarter-hour.

Qualifications of pilots for patrol flying are covered in Air Operations Handbook. Usually pilot qualifications are investigated thoroughly when flying contracts are made (flight checks by regional F. S. pilot). If the contractor substitutes or changes pilots, the observer should immediately inform his supervisor, who will initiate the required action. Observers should not start a flight with any pilot who has not been officially approved.

Signal code cards for use by smokejumpers, fire fighters, and airplanes in distress (see Air Operations Handbook) should be a regular part of the aerial observer's kit. Signal streamers should also be included for emergency use.

Use of parachutes as prescribed in the Air Operations Handbook will be followed. Observers should check repacking dates and notify the dispatcher in time to obtain another chute. Observers should also refer to the Safety Code for parachute as well as other safety regulations.

Smoking while in flight shall depend upon the type of airplane, facilities provided, and pilot or contractor's wishes. In general, although smoking of cigarettes or cigars is not strictly prohibited, it is not good practice in facric-covered ships or when rough air is encountered. Pipe smoking is prohibited, as are all types of smoking during ground operations of the plane.

C.A.A. rules and regulations applicable to flight of aircraft shall apply at all times to patrol flights. Observers should become acquainted with these rules and insist upon rigid compliance.

Detection Planning

Some time should be devoted to training of air observers in the mechanics of detection planning if they are to take an active part in refinement of patrol routes and the development of air-coverage maps. Usually this training is done on an individual basis rather than made a part of the group training. Suggested subjects are as follows:

1. Development of "important-area" maps and their use in selection of lookouts, ground patrols, and in air detection.

2. The development of patrol routes and air-coverage maps.

3. Degree of coverage from lookouts, cooperators, air patrol and the development of coverage composites.

4. Analysis of fire dangers, lightning and fire occurrence, and the devlopment of patrol schedules.

Check List of Air Observer Duties

Pre-flight duties

1. Select proper class and type of patrol. Usually this is done with the assistance of the central dispatcher, but qualified observers are often delegated this responsibility under the general supervision of the central dispatcher.

2. Assemble current information on rainfall, general storm areas, going fires, and requests for special action from the distrcit ranger. Prepare information map and notes.

3. Check equipment and forms needed on patrol (observer's kit).
   a. Flight maps and small-scale current information map
   b. Aerial photographs with coordinate grid, if needed
   c. Dark glasses (U. S. Air Force "rose smoke" recommended)
   d. Binoculars

e. Watch
f. Report forms and notebook, pencil
g. Notes and current information not on information map
h. Protractor and ruler
i. Camera with fast black and white film
j. Fire area computer.

Suggested equipment in addition to observer's kit for fire scouting. The following may be varied according to conditions and circumstances:

a. Tatum holder
b. 9½" x 12" envelopes (2)
c. Organization map of large fire
d. 6" ruler
e. Spring clips (3)
f. Scotch tape, transparent
g. #2 pencil with pocket clip (1)
h. #3 pencil with pocket clip (1)
i. Message droppers (6)
j. Grease pencil
k. Aerial photos of fire
l. Aerial photo coordinate grid
m. Form 878 map sheets
n. Set of colored crayon or pencils, red, blue, green; optional, brown, yellow.

4. Assemble mail and small freight, to be dropped to lookouts or crews on the next flight, package and attach proper parachute if needed.

5. Observe pilot in making preflight inspection of aircraft.

6. Stow equipment and freight in plane in proper location and secure.

7. Ground check of radio installation.

8. Inform pilot of patrol route and known deviations such as fire scouting, freight delivery, etc.

In-flight duties

1. Note takeoff time in notebook.

2. Check radio communication soon after leaving the field.

3. Contact lookouts via radio for special information on strike areas, sufficiently in advance that adjustments to flight path can be planned.

4. Search diligently and methodically for hard-to-see smokes.

5. Adjust flight path as necessary to obtain maximum coverage and best visibility of area under detection.

6. Adjust flight path as necessary for intensive search in areas of special hazard, such as strike areas reported by lookouts.

7. Observe performance of pilot and the care used in following prescribed courses or planned patrol routes.

8. Make aerial delivery of freight with a minimum of lost patrol time. Plan deviations from patrol route in advance to minimize loss due to change in course and altitude. Record extra flying time required to make freight delivery.

9. Keep track of flight time and air speed. Don't be guilty of causing pilots to use too much of the reserve supply of gasoline through short extensions of the trip. Avoid joy riding, game counting, and other unauthorized flying.

10. Turn plane as necessary for best coverage of false smokes.

11. Note landing time in notebook or log sheet.

Between-flight duties

1. Maintain current records of flight time, number of patrols, fire action needed to improve detection results, and weather and other information needed in planning class of patrol, frequency of observation, and special flying.

2. Maintain observer equipment and continue to improve flight maps, seen-area coverage maps, and patrol-route planning.

3. Usually aerial observers act as relief dispatchers when necessary and time is available. This affords much training in weather measurement, fire action and analysis, and other duties of benefit to the aerial detection. Often times the duties above may be accomplished while acting as relief dispatcher.

Aerial Observation Techniques

Aerial observation is a specialized job involving many techniques. The success of the unit depends to a large extent upon the qualifications, experience, training and sound judgment of the personnel involved.

Systematic, planned and detailed air observation as used in Region 1 and elsewhere is new when compared with other detection means. Considerable progress has been made in a few short years, however, and it is hoped that still greater progress will be made in the near future. Here is an interesting and fertile field for devlopment and research! Aerial observers have in the past contributed greatly to the techniques given here. We know they will be further improved and developed as more experience is gained and new methods are proved by statistical analysis.

Learning the Country and the Patrol Routes

One of the most important requirements is a thorough knowledge of the area. The greater this knowledge the better will be the detection results. Although the air observer has much more area to learn, and will encounter a greater variety of visibility conditions, the principles of fire detection are essentially the same as for the lookout-fireman. The experienced man, having looked many times at a timbered expanse, will develop a picture in his mind which changes slowly as seasonal changes actually occur. If a smoke or other visible object not previously seen suddenly appears, it is very likely his eyes will unconsciously return to that part of the picture which has suddenly changed, and does not fit with the mental image developed through many looks at this particular area. The airplane provides the observer with a moving platform, instead of a lookout tower, from which he searches for smoke. The flight path and elevation have been carefully selected -- just as the lookout-tower location was carefully selected -- to give coverage over certain areas. Whenever possible pilots should fly reasonably close to the preselected route so observers will see the area from approximately the same angle.

Fires are discovered by looking at the smoke. Time spent by an observer in studying the map on his knee is subtracted from the effective search time. He must learn the country and patrol routes so a minimum amount of time is used in checking the map for location or for conformity with established routes. At a travel speed of 100 miles per hour, considerable area is lost with only a short look at the map.

It is recognized that time is required to learn the country and training flights are scheduled during low fire dangers for this purpose. Observers will gain a very good knowledge of the area by working on patrol-route planning and study of topographic maps. The map study should at all times precede the training flights. Do not attempt at first to learn details of topography or minor drainages, but confine the study to names and locations of the major drainages and well defined peaks - particularly those with lookout towers which are easily recognized from any direction. Learn your country in the following order:

1. Major drainages and dividing ridges with prominent peaks or landmarks.

2. Progress to intermediate-length drainages and minor peaks.

3. Study aerial photographs of difficult areas to become familair with general ground cover, exposed ground, large burns, etc., not shown on maps. On training flights attempt to establish the location of these landmarks on the flight map.

4. Trace out the road locations, learn the location of easily visible large structures, such as mines, small towns, and other manmade features helpful in getting a general location and which will be seen along the patrol routes.

5. Progress gradually to minor drainages and ridges which will be helpful in quickly orienting yourself for fire location.

6. And last of all, develop a mental picture of the skyline as you fly the area and as it looks from various positions along the patrol route.

In making training flights check the patrol map often and carefully to insure that the pilot is flying a proper course and insist that this route be adhered to as closely as possible. Use of the map now for pilot and observer training is necessary in order to know the routes thoroughly when maximum search time is needed.

Area of Responsibility

A common failure of new observers is to attempt to cover too much area. By doing so they cut down on the effective search time in the area of responsibility. Here is a key point in aerial observation which cannot be stressed too often or enough!

Observers should study cross-section profiles and seen-area composites and maps to get the areas of responsibility firmly in mind. These are not always associated with a distance limitation such as the 5 or 10 miles on each side used in preliminary patrol-route planning. More often they are associated with the immediate topography or the expected visibility conditions. We know for example that south slopes present problems of detection due to dry fuels and light-colored smokes. Grass areas must also be viewed at closer range to discover small smokes due to the light color and volume. Patrol routes are arranged to obtain proper coverage when these conditions are known.

In general, when a midseason patrol planned for 5 miles each side of the plan is being made, the air observer should confine approximately two-thirds of his observation time to areas seen between the plane and the next high ridge on the sides. This ridge may be 3 or it may be 7 or 8 miles away, and anything seen over that ridge is usually well beyond the detection limits. Any discoveries made at distance are usually made during a period which has been planned to rest the eyes. Do not spend time in searching "the wild blue yonder" of air force fame.

Time and Length of Observations

Studies of flight speeds and their relation to fire discoveries have been conducted. In this study three patrol planes, each with an experienced observer, were directed to fly a predetermined course at 80, 120, and 160 miles per hour. (The pilots had been oriented and had practiced flying the course on an identical flight path and at identical altitudes before the tests.) Smoke candles were lighted and a series of small smokes were maintained along this patrol route. Results of the tests proved that there was little if any difference in detection of small smokes within the 80-160 m.p.h. speed range. If planes with 160 m.p.h. cruising speed were available and suitable for detection purposes at a reasonable cost per hour, we would undoubtedly use them in preference to slower airplanes. The higher cruise speed would enable one plane to cover a larger area, or increase the frequency of observation considerably over the same area, and should improve detection results.

Studies of established patrol routes indicate that approximately 1 out of 3 minutes may be used to rest the eyes with little loss to detection. These rest periods are not at regular intervals, however, and will vary with different locations along the patrol route. The studies were made at approximately 100 m.p.h. cruising speed. The experience of the observer and his knowledge of the

area are also contributing factors. Observers should study figure 1 carefully and pattern general search time along similar lines. The search pattern is of considerable importance. Except for a check on false smokes, country once covered is gone. Don't look back!

Altitude of Flight

Flight altitude is an important factor in seeing the small smoke. Although small smokes can generally be seen more easily from a plane 2/ than from lookouts, the primary consideration still remains that of distance. We have on several occasions detected or discovered very small smokes while on intensive patrol or searching some special area at low elevation that could not be seen from the average patrol elevation.

There is of course a limit below which we cannot normally fly and obtain sufficient coverage. See figures 2 and 3, which indicate the expected increase of coverage with increase in elevation above the average for the area. These averages and the percent of coverage may be easily determined for your particular area by analysis of cross-section profiles used in planning patrol routes.

Note that at approximately 1500 feet above the average elevation for the area the percent of coverage "breaks" and the increase in seen area begins to diminish with each increase in elevation. We therefore established 1500 feet above the average ground elevation as approximately the best elevation for patrol flying when visibility is limited and considering that we must discover the small smokes. Large smokes are easily seen from any altitude, and if it were not for the hard-to-find smokes, we would of course fly at higher elevations to obtain maximum seen area.

From the above it may be reasoned that on extremely clear days the elevation might be increased without loss of detection on the small smoke and with some gain in total seen area. Also on days when because of fire danger or wind, small smokes are quickly fanned into life, it might be advantageous to increase the general flight altitude to realize additional seen area.
A study of elevation, distance, size of fire on discovery, visibility, and fire-danger factors would be very important to further refinement of flight altitudes.

Angle of Observation

Closely related to flight altitudes, the angle of observation has been found to be of minor consideration at the distances now used in detection. Field tests conducted to date indicate that extreme changes in altitude would be required to produce any measurable effect on smoke visibility other than that caused by the distance between observer and the smoke.

Sun Angle

We suspect that sun angle has some bearing upon smoke visibility 2/ but so far experiments have been inconclusive. The sun angle with respect to the observer is also related to angle of observation and the area of smoke effected by the sun rays.

2/ HARRIS, H. K. and FAHNESTOCK, G. R., Aerial observer versus lookout. Fire Control Notes, April 1954.

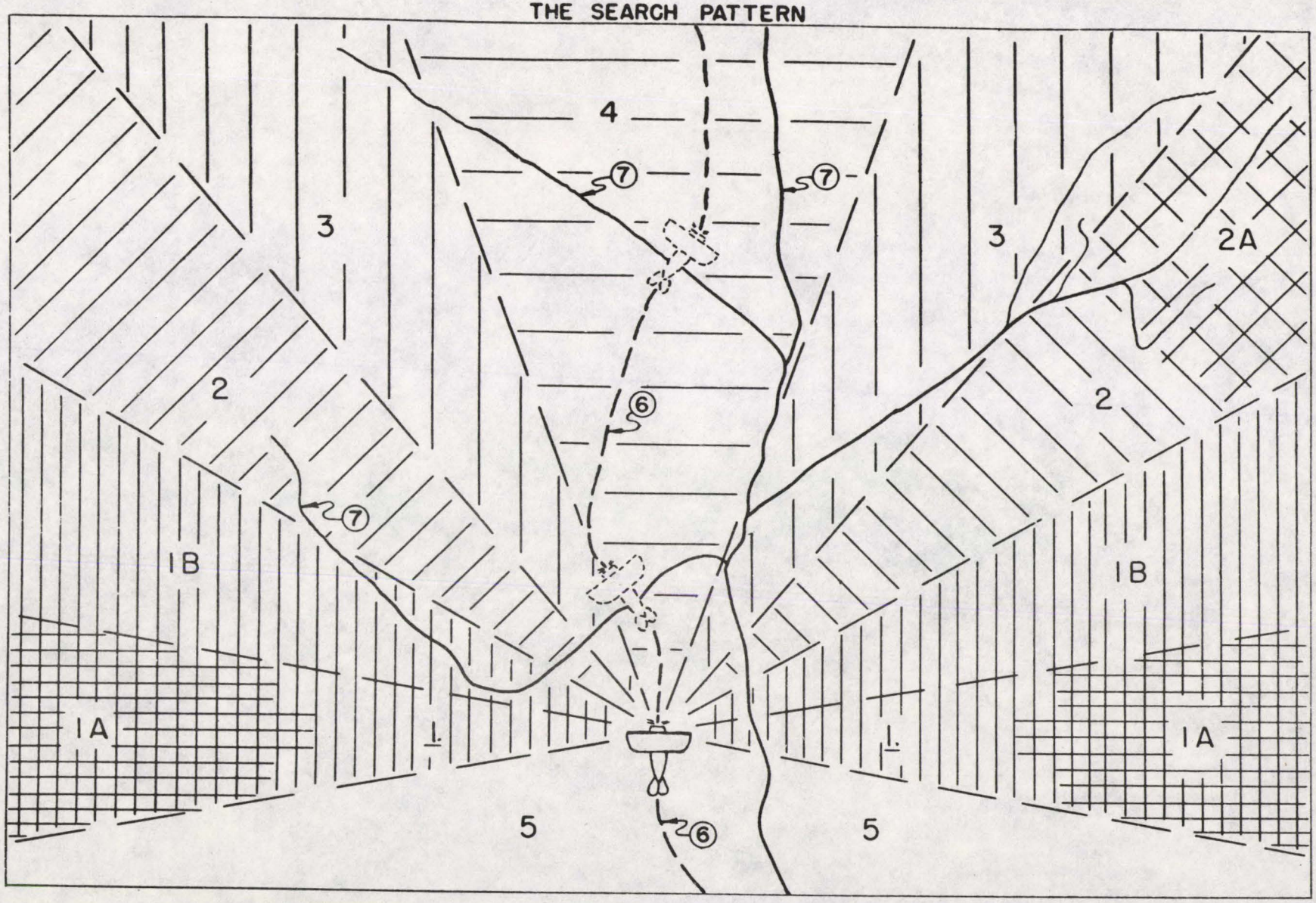

Figure 1

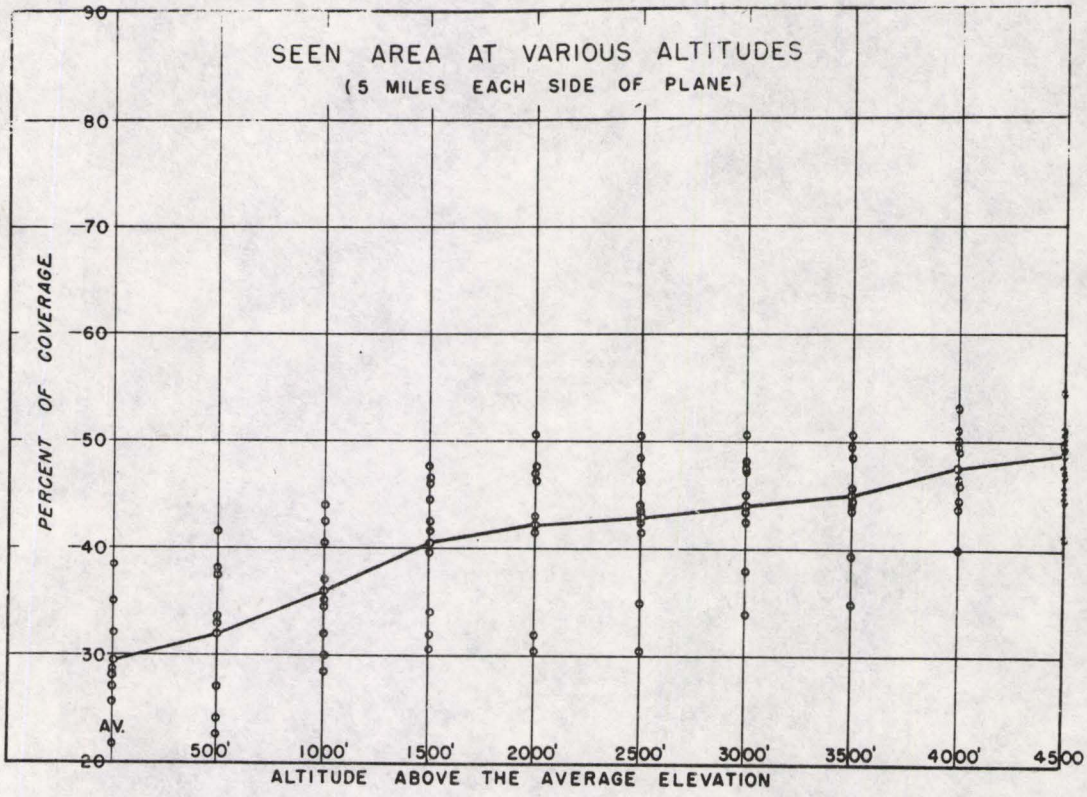

Figure 2

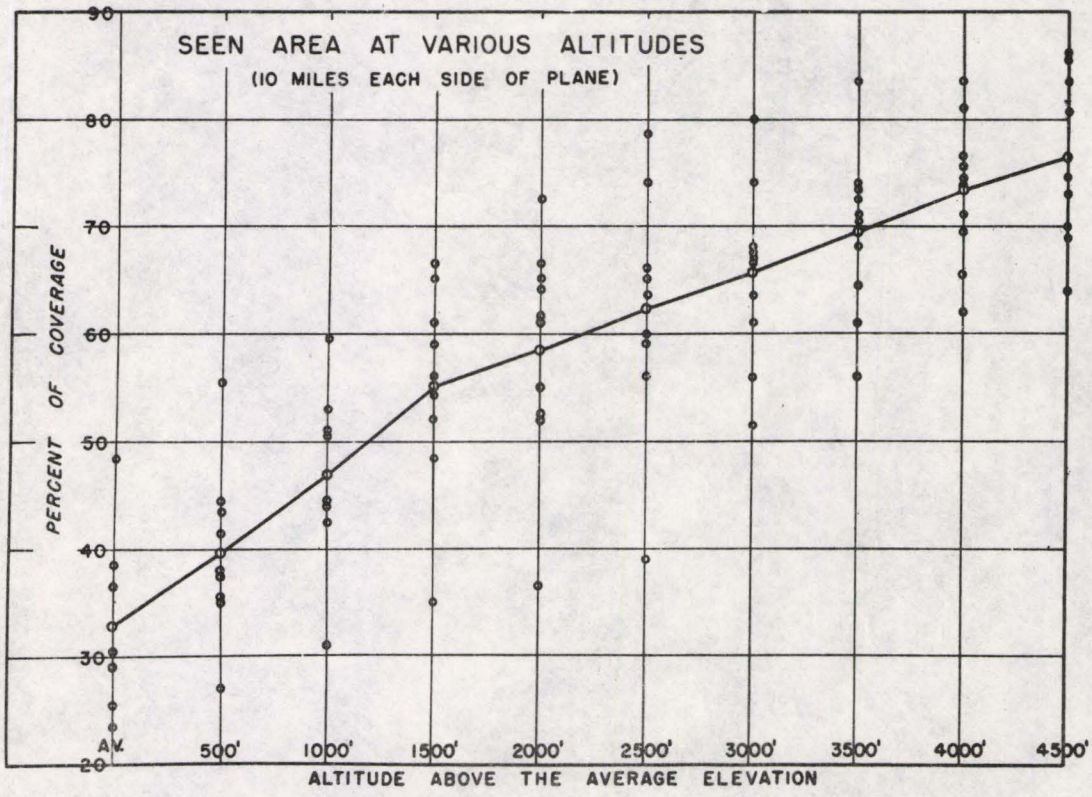

Figure 3

Figure 4 -Choosing patrol routes.

1. Major drainage--longest streams common to the area.
2. Secondary drainages--intermediate streams.
3. Minor drainages--minor streams and draws.
4. Major divides--highest common to area.
5. Secondary ridges--intermediate ridges dividing the intermediate drainages.
6. Minor ridges--divides minor streams and draws.

7-9. Flight strips.

Visibility Factors

Effects of haze are readily apparent to the experienced lookout or air observer who has searched for smoke in an area lying between his position and the sun. In this respect the air observer has a distinct advantage over the lookout in that he may adjust his observation platform to minimize the effect of haze.

Haze is caused by sun reflection from smoke, dust, moisture and other minute airborne substances. At times it appears impenetrable. It has been proved, however, that a smoke column will be seen as easily looking towards the sun as it will in looking away from the sun, provided the smoke is also in the sun. In this case, the smoke column receives the same magnification or illumination as the particles which are causing the haze effect. If the area under observation were all in direct sunlight, the observer would not need to adjust the flight pattern to minimize the effects of haze. The joker in the deal is that the smoke may be in the shade! Shadows caused by hills, small clouds or timber may be preventing the illumination or magnification of the smoke, while the observer may still be looking through a considerable distance filled with haze.

When the observer encounters these conditions on north-to-south or south-to-north flights, the general practice is to shift the line of flight closer to the sun. This reduces the distance to the area under observation and reduces proportionately the haze covering the area of responsibility. The distance moved at the present time is according to the judgment of the observer. Until we have actual test and statistical information from which to establish guidelines, observers should adjust flight courses generally as follows:

1. Unless an estimated 25 percent or more of the responsible area between the observer and the sun is shaded, no deviation will be made. The amount of shadow will vary with topography, cloudiness, and time of day. Moving towards the sun increases distance of observation "down-sun" and may offset any advantage gained under these conditions.

2. When it is estimated that cloud or hill shadow covers 25 to 50 percent of the responsible area, observers should move flight route closer to the sun. (Suggest approximately 1 mile for 5-mile observation strips, and 2 miles for 10-mile strips.)

3. When it is estimated that cloud or hill shadow covers 50 percent or more of the responsible area, observers should move flight route to approximately midway between the previous route and the limit of the responsible area.

Of equal importance and certainly to be considered are special hazards. For example, if the primary purpose of the patrol is lightning coverage and the principal strike area is "up-sun", observers should not hesitate to make drastic adjustments to the patrol route since the chances for fire occurrence are many times greater than in the area "down-sun."

We are sure that by this time some of you have thought of another and important possibility which will minimize the effects of haze. Effects of haze are largely confined to certain directions in accordance with the time of day. The greatest effect is noticed on north-to-south or south-to-north flights before 9:00 a.m.

and after 4:00 p.m. when looking towards the sun. You will notice that figure 1 illustrates the most important areas for detection and that these areas are especially affected. On a west-to-east flight before 9:00 a.m. and on an east-to-west flight after 4:00 p.m., the haze effect is confined largely to areas ahead of the plane. Under these conditions the smokes will later show in the area most important from the observation standpoint and which is not affected too greatly by haze.

A study of the general patrol layout and time required to make the patrol will bring out possibilities of reversing direction of travel at certain times for greater effectiveness. In some cases all or part of the patrol may be delayed or advanced enough to change the haze conditions on certain sections.

Effect of Background

Visibility of small smokes is affected to a considerable extent by the nature of the background. In general a dark background provides the best detection, and a mottled (alternately light and dark with irregular pattern) probably presents the most difficult for the air-detection standpoint. Light-colored vegetation such as cheat grass on an open slope, or a light layer of pine needles in open ponderosa-pine country are also difficult due to both the color of the background and the density and color of the smoke. Smokes with a sky background are easier to detect by plane than from a lookout because of the angle of observation. At normal distances usually some part of the smoke will have a background color suitable fordetection and the change in angle of observation due to travel will also change the background effect.

The effects of background will become apparent with experience in fire detection. Spend more time looking at areas with a mottled background and where the background is generally light-colored.

Effects of Fuels and Moisture

Dry fuels produce more heat and less smoke than wet or green fuels. Observers should spend more time observing in areas known to be dry such as south slopes, lower elevations, and the "dry" areas as shown on rain maps. Fires in open ponderosa-pine type very often burn in the light, dry fuels with little smoke. Grass fires on open slopes will sometimes be seen only as a "dark spot which gets bigger."

Areas covered with dense reproduction require little observation time both because of green fuels with more smoke, and the favorable background.

Observation Methods

Figure 1 illustrates some of the principles of effective air observation. In this instance it will be seen that systematic search time may be more profitably spent in certain areas and that other areas should receive only casual observation.

Fires at distance, although clearly visible, will require more search time to detect just because they are small. If this area will come under observation again and at a closer range, do not spend valuable search time until it can be most effective. There are also areas visible only from some certain place along the patrol route which must be oberved at the proper time, regardless of distance.

The legend for the search pattern diagramatically presented in figure 1, The Search Pattern, is as follows:

"1" The most important area. Confine observations largely to this sector. This country will soon be lost to view.

"1A" Outer limits of important area. Requires more time because of background and distance.

"1B" Important area for coverage. Must be looked over from this point to take advantage of seen area. It will soon occupy position "1".

"2" Important to cover drainages that will later be hidden by curving ridges.

"2A" Will require more observation time than "2" because of distance and background, and may contain important area that will later be hidden.

"3" Not as important as "2" because will be in closer range. There may be areas visible only from the present position. Cover with general observation as a rest for the eyes.

"4" Area ahead. Use for resting eyes. Note any areas which are visible from this point that will later be hidden by the body of the airplane.

"5" This area has gone by. Look back for checking on probable new smokes, troublesome "false smokes" or for coverage for areas only visible from this point. Generally the flight path will reduce the amount of coverage which requires the observer to look over his shoulder. Some observers desire to give a general coverage of extensive areas just covered. This can best be done by changing the airplane position when necessary.

"6" Note the flight path with relation to ship position. It has been planned to place the airplane in the best position for observation.

"7" Note drainage with relation to the airplane positions, time required for observation, and position of airplane when drainage is open for observation.

Observers should develop a habit of systematic search. Usually this can best be done by taking one area, such as a continuous slope from valley to ridgetop, dividing into parts and then scanning carefully that part which lies in the best position. If the area is covered by a series of "looks" which start first near the plane and progress outward to the far limits of the responsible area, we divide the country into imaginary pie-shaped wedges. More time is spent searching at distance than close in. Some observers accomplish this by directing the search from distant ridge back towards the plane about midway and then back to the ridge again.

The important point is to use some systematic procedure and recognize where to spend the most search time and where to observe in a casual way.

From time to time the eyes will return to a "false smoke" which for some reason or other has attracted attention. In most cases a quick look with the binoculars will settle whether or not it is a real smoke. Usually a look at another angle will change the background enough that recognition is certain. It is permissible to look back to check false smokes when necessary. If the false smoke persists after two or three "looks" from different angles, observers should direct a change in flight path to make sure before proceeding.

Position plane for best observation by proceeding along a slightly zig-zag course. This should never be an abrupt change in course nor does it need to be more than 4 or 5 degrees. A slight movement of the nose of the ship to left and right, however, will open up areas which are underneath and ahead of the plane to the pilot or observer for detection at close range. This movement also eliminates the chance that a smoke may be obscured by light streaks on windshield or airframe members.

Rest periods are obtained by using approximately one minute out of three for casual looking ahead of the plane. Observers will find that this relaxation from intensive and systematic searching is necessary. It does not mean a material loss of detection time since many fires have been discovered in casual search and usually the immediate area is well covered between these rest periods. Only when necessary or during training should the observer study the map or look at material or objectsinside the plane. If a fire is discovered at a distance, observers should not neglect the search for others while traveling to the smoke.

Choosing Special Patrol Routes

Figure 4 illustrates two methods of arranging the patrol route. Normally patrol routes are laid out parallel to the major drainages since this gives an advantage in double-up coverage. Special patrols for lightning strike areas, or where intensive coverage is required, may necessitate a different pattern to obtain the best position for observation. Sometimes a flight route which parallels the ridges will afford maximum observation at close range into minor draws and drainages. The coverage obtained by a flight course, illustrated by "9" in figure 4, which parallels the ridgetops is not as high per hour as that obtained by flight course 7 or 8.

Visibility Aids

Colored glasses are required for aerial observation. Although natural vision is best for all conditions, there is considerable glare and eye strain which must be relieved during long flights. Glasses should be of quality manufacture rather than the common dime-store type. Lenses should be optically correct and of uniform coloring. We have yet to determine the best quality or color for the average observer, although many kinds including polarized glasses have been tried. Observers have often indicated a preference for various tints but it is believed this is largely a matter of personal opinion.

Ultimately we believe that the various tints will prove beneficial under certain conditions and more than one pair may be made available for observers.

Binoculars should be carried by all observers for checking on false smokes, for detailed observation of small areas, and for fire reporting and scouting. A wide field of view is desirable with comparatively low magnification -- approximately 4-power. These are not always available and are quite expensive. The standard 6 x 30 binoculars, as produced according to army specifications and with hard-coated lenses, do very well. The higher magnification (6-power) makes them difficult to use in low-level scouting work until the observer has had considerable experience.

Any binoculars used should be adjusted previously to the eyes of the observer, and markings observed so the exact setting may be checked and duplicated.

Colored viewers. Certain photographic filter papers have been given incomplete tests without supportable conclusions. It appears that some types of filters used as viewers are definitely beneficial in separating smoke from dust. It is possible that further testing may produce a series of viewers which would aid materially in checking on false smokes.

Use of Maps and Photographs

A contoured map on 1/2"-per-mile scale is most widely used for patrol maps. Methods of folding, construction of map boards, and special arrangements have been tried. Success or failure depends pretty much upon personal preference. Space limitations in small planes require that maps be arranged for ready reference without refolding.

The most common arrangement is a series of small map boards, approximately 14" x 16", properly indexed and arranged, and with a 1-inch overlap at the edge of each board. A binder containing a series of strip maps may also be assembled and indexed so when opened at the proper page and laid out, the double page is in effect a map board. Reference numbers are shown on each page to enable the observer to quickly turn to the proper section regardless of the flight path or direction. Patrol routes, elevations, and other information are shown on the patrol maps.

Aerial photographs should be arranged and indexed so the proper photo of any area along the patrol route may be quickly selected. Whenever possible section lines should be projected on the photo and the section numbers shown. To avoid having too many markings on the regular patrol maps, a small-scale map is sometimes used, on a separate map board, for photo numbers and other reference information.

Oblique photographs are sometimes available but are of little value in air detection unless especially taken from known points along the patrol route. Principal use is in aerial seen-area mapping.

Seen-area maps are seldom carried by the observer except when the flight is primarily engaged in this work for planning or training purposes.

Map-Reading Instructions

Map reading is particularly important in aerial detection. A contoured map is essential, if aerial photographs are not available, for accurate fire location. If the contoured map is not available in 1/2"-per-mile scale, other scale maps should be obtained and arranged for reference in the plane and for training.

Map training should be carefully and completely done. Air observers must become so familiar with the map of the area that the visualized topography is quickly and easily transferred from ground to map or map to ground. With experience the contoured map will become essentially the same as a picture, in that ridges, draws, peaks, etc. will be quickly and accurately recognized.

In addition to the training commonly given (scale, legend, contour interval, sections, townships, ranges, etc.) aerial observers should practice describing the topography along a sharp line drawn in any direction across the map. They should be able to quickly and accurately describe the ground surface as they travel along this line as follows:

1. When travelling up or down hill
2. When "sidehilling" or paralleling contours
3. When slopes are steep, moderate, gentle, or flat
4. When travelling directly up or down a slope, or at an angle to the slope
5. When travelling along a ridge, the nature of the ridgetop -- narrow, rounding, etc.
6. When crossing or paralleling the point of a ridge
7. When travelling over the top of a peak or mountain -- its approximate shape
8. When crossing streams, shallow draws, etc.

If sufficiently familiar with the map, observers should describe the topography without hesitation. Also test by asking questions regarding elevations of ridgetops, creek bottoms and estimated percent of slope between two points.

The development of cross-section profiles is necessary for refinement of patrol routes. After observers become sufficiently accurate at map reading to make these profiles, they will quickly gain in map-reading ability. Development of patrol routes through seen-area mapping by profile methods, determination of proper course and elevation by profiles, and sampling of areas for general patrol elevations should be made a part of every observer's training.

It is important that the flight maps be of uniform scale and that training be done on these maps. It is extremely difficult to change from one scale to another quickly.

Fire Location

Orientation for accurate fire location is usually necessary unless the fire is adjacent to a known landmark shown on the map. Observers should be cautioned to check every fire location carefully. The most common mistake is to locate the fire in accordance with a stream fork or some topographical feature adjacent to the fire, but selecting a similar but different feature on the map. Always check a fire location by comparing progressively the ground topography with that shown on the map until a known point is reached (one which you are sure of, both

on the ground and on the map). Usual practice upon sighting a fire is as follows:

1. Proceed towards the smoke, using map to orient the plane position.

2. Observe progressively the topography and compare with map.

3. Spot the fire in accordance with local topographic features.

4. Before leaving the area, check the location.

In extremely difficult cases observers may need to use the following procedures:

1. Fly to a known location and then proceed towards the fire, checking topographic features progressively and timing the flight from the known point to obtain an estimated distance. Pilots should assist.

2. Triangulation method. Line up the fire between two known positions easily seen on the ground, and determine location along this line by local topographical features.

3. If necessary, the fire may be lined up between four known topographical features and location plotted on the map.

The last three procedures require more time, but may be used in difficult locations or where an extremely accurate location is required. An example might be a small smoke that will be extremely difficult to see from the ground or which may die out later.

Fire Scouting

The report requires more than just an accurate location. (See forms for fire reports.) While in the locality of the fire obtain the following information:

1. Size

2. Probabilities

   a. fuels, winds, slopes, barriers
   b. volume and character of smoke
   c. rate of spread
   d. resistance to control

3. Quick estimate of control time and suppression needs

4. Best travel routes for smokechasers or crew

   a. where can smoke be observed?
   b. difficulties of travel route
   c. landmarks along travel route
   d. instructions for finding fire

5. Special equipment needs

Don't forget to look around for other smokes. In several instances due to concentration on the fire at hand, nearby smokes have been missed. Every going fire will be checked by air during each patrol flight and current conditions reported.

Large-fire scouting is essentially the same as for small fires. More area must be covered and more often smoke obscures fuels, barriers, etc., in advance of the fire. In addition to the above, observers should attempt to obtain information regarding:

1. Effective control work accomplished
2. A map of the fire where the edges may be observed safely
3. Dangerous or uncontrolled sections and an estimate of needs
4. Fuels surrounding the fire where smoke permits their observation.

Although low flying is necessary, extreme caution should be observed by pilots when flying through smoke and where downdrafts might be expected. Heavy smoke should be avoided at all times.

Fire Reporting

Fire reporting should be systematic and careful. Follow closely fire report forms and give complete information. Use radio properly to insure clear reception and minimize noise in the microphone. Have pilot throttle back during transmission. Speak slowly and distinctly. Do not repeat unless requested to do so. Transmit your report through the nearest lookout unless you are directed to report to the dispatching center. Obtain confirmation on receipt of report.

Aerial Delivery

Aerial delivery of large or heavy bundles by parachute is not permitted in the light aircraft commonly used for air patrol. It has been found, however, that aerial delivery of small bundles of fresh subsistence, mail, etc., may be handled with safety if observers and pilots observe proper precautions. Usually deliveries of this kind are accomplished while on regular patrol and at little cost for flying time. They represent a considerable saving when special trips by a packer or other personnel are required. A package of fresh meat and the mail, delivered to a lookout, often delays the request for a supply trip and contributes greatly to morale.

Whenever aerial delivery is anticipated observers and pilots should receive special training in this operation.